INDIVIDUAL
PROTECTION

Advanced Soldier Ballistic Protection

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DIRECTORATE

Current Ballistic Protection

•*Interceptor & Small Arms Protective Insert*

Vest: 7.8-8.4 lb, Torso coverage
Protects against:
Conventional frag, handgun
SAPI: 4 lb
Conventional ball rounds

•*Full Spectrum Battle Equipment (FSBE)*

Reduced **area of coverage**
SAPI

•*BALCS*

Vest: 6.5 lb
Level IV Plate: 6 lb

•*Standard PASGT*
•*Modular/Integrated Communications Helmet (MICH)*
•*Lightweight Helmet*

Helmet : 3 lb
Protects against conventional frag, 9mm
Improved Suspension system

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Objectives

. . . **Develop/insert advances in materials technology to *improve protection* and performance of armor systems against conventional and emerging ballistic threats while *minimizing penalties* associated with the increased levels of protection.**

. . . ***Provide tools*** **to benefit the development, design, test and acquisition of personnel armor.**

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Why do this work?

- **Armor is a significant contributor to the load of the individual warfighter.**
  - **Today's armor employs "state-of-the-art" materials (ceramics/textiles) in traditional configurations for conventional threat protection.**
  - **Minimal protection is presently offered against the emerging threats.**

- **Current state-of-the-art technology configurations will not meet future personnel armor systems weight goals to protect against conventional or emerging ballistic threats.**

- **Existing materials technology have not been fully exploited to the optimal performance levels.**

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Why do this work?

- **Current methodology(s) for assessing the behind armor effects of non-penetrating impacts onto body armor (helmet and vests) tend to assess the mechanical performance of the armor system.**

- **Standards to assess "blunt trauma" that are presently employed have a limited biomechanical foundation**

- **Current casualty reduction assessments are performed using models such as CASRED or Full Spray Lethal Area that are limited due to:**

  -Lack of flexibility to represent multiple fragment materials (e.g., steel, tungsten)
  -Poor representation of human targets and body armor coverage
  -Limited representation of fragment penetration algorithms
  -No capability to easily change algorithm parameters
  -Lack of adequate representation of casualty effects

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Payoffs

- **Light weight personnel armor with significant increase in ballistic protection - Depending on threat - up to a 40% reduction in ballistic materials weight over start point of this DTO**
- **Better protection and lighter weight equates to improved survivability and tactical mobility for the individual**
- **Enhanced analytical tools for body armor development, test and evaluation and acquisition/ fielding**
- **More realistic survivability assessment**

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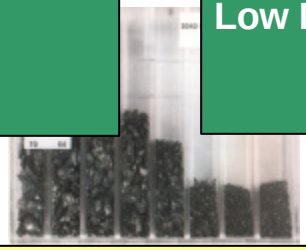
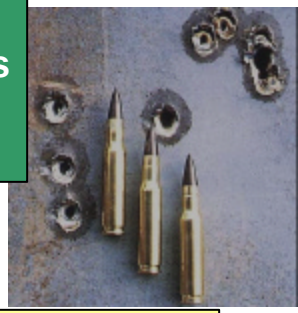
Conventional Threats
Steel Fragments
Small Arms Bullets –
Lead and Steel Cored



Emerging Threats
Low Mass, High Density Fragments
Small Arms Bullets –
Tungsten Carbide Cored

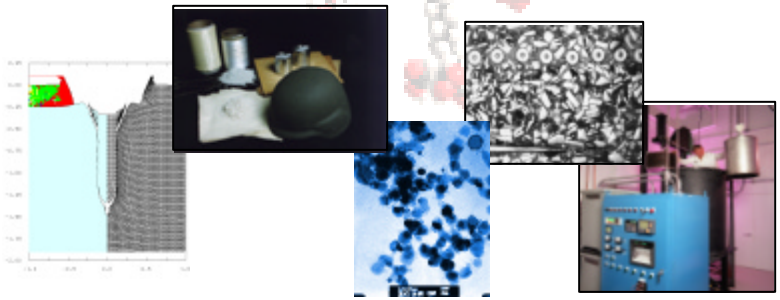


Behind Armor Effects Methodology

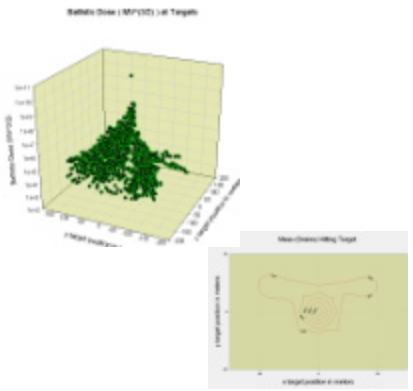
Conduct experimental (tissue & test fixture), analytical and numerical assessments of non-penetrating impact on body armor/body

Advanced Technology Development

- New high performance polymers/ fibers/composites
- Nanotechnology
- Advanced ceramics & metals
- Enhanced predictive modeling
- Material systems integration



Casualty Reduction Analysis Model



Develop/update models for armor system performance from threat definition to incapacitation effect

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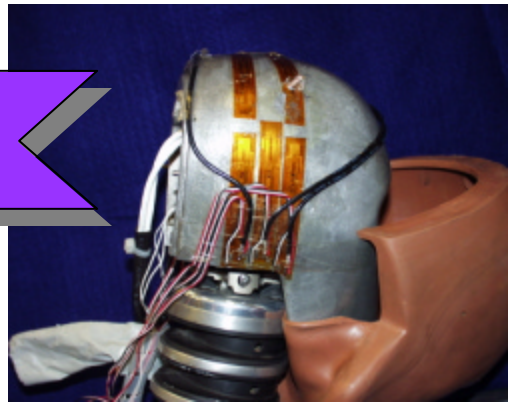
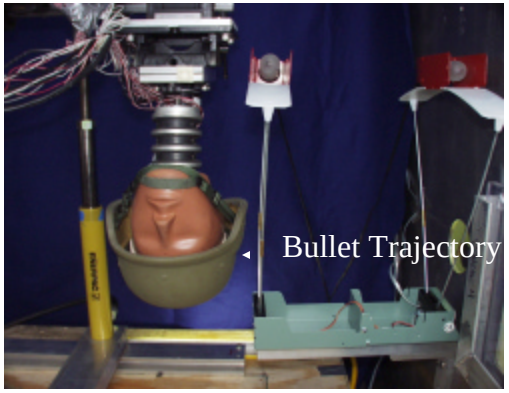
Behind Armor Effects - Helmet Assessment Methodology

- Objective, dynamic biomechanical test method for accurately determining skull fracture potential of non-penetrating ballistic impacts on helmets.
- Human Impact Location
  - Temporoparietal Bone
  - Near the Lambdoidal Suture
  - Above the Frankfort Plane

First objective method
In the world
based on biomechanics



- Validated through mechanical and cadaveric experimentation
- Established a risk of injury (fracture) curve for 9mm impacts on the helmet at various velocities



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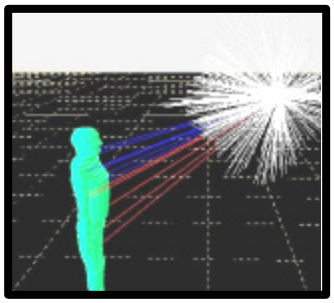


Integrated Casualty Estimation Methodology

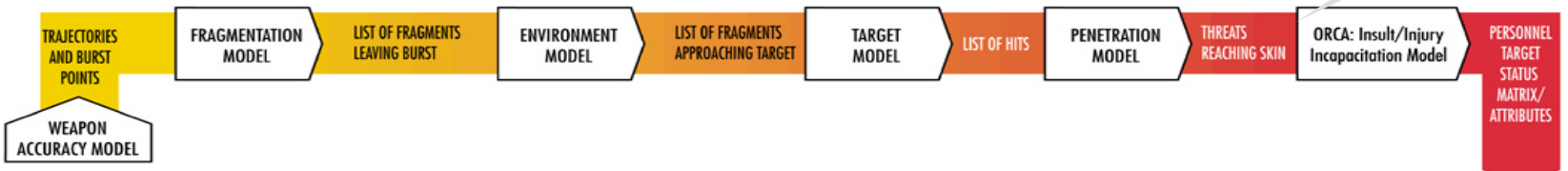
Key Accomplishments:

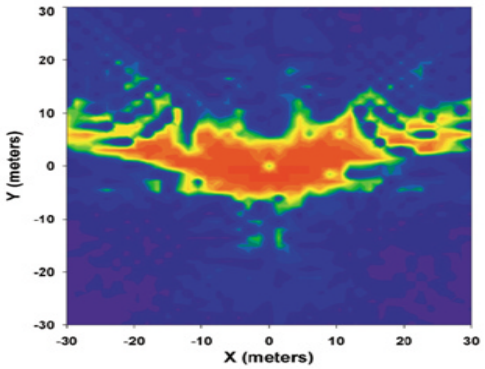
- **Implemented Interface with Operational Requirement-based Casualty Assessment (ORCA) Library Functions**
- **Implemented Cunniff Equations For Ballistic Penetration**
- **Implemented Improved Representation of Munition Arena Test Data**
- **ICEM website, codes, and user's manual, available on-site, for authorized users**

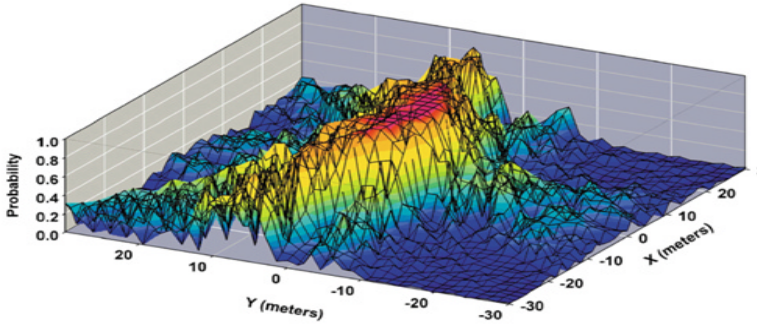
ICEM Version 1.0 Scheduled for Release in Mar 02

http://www. stiusa.com/ icem

Integrated Casualty Estimation Methodology







Probability Of Incapacitation

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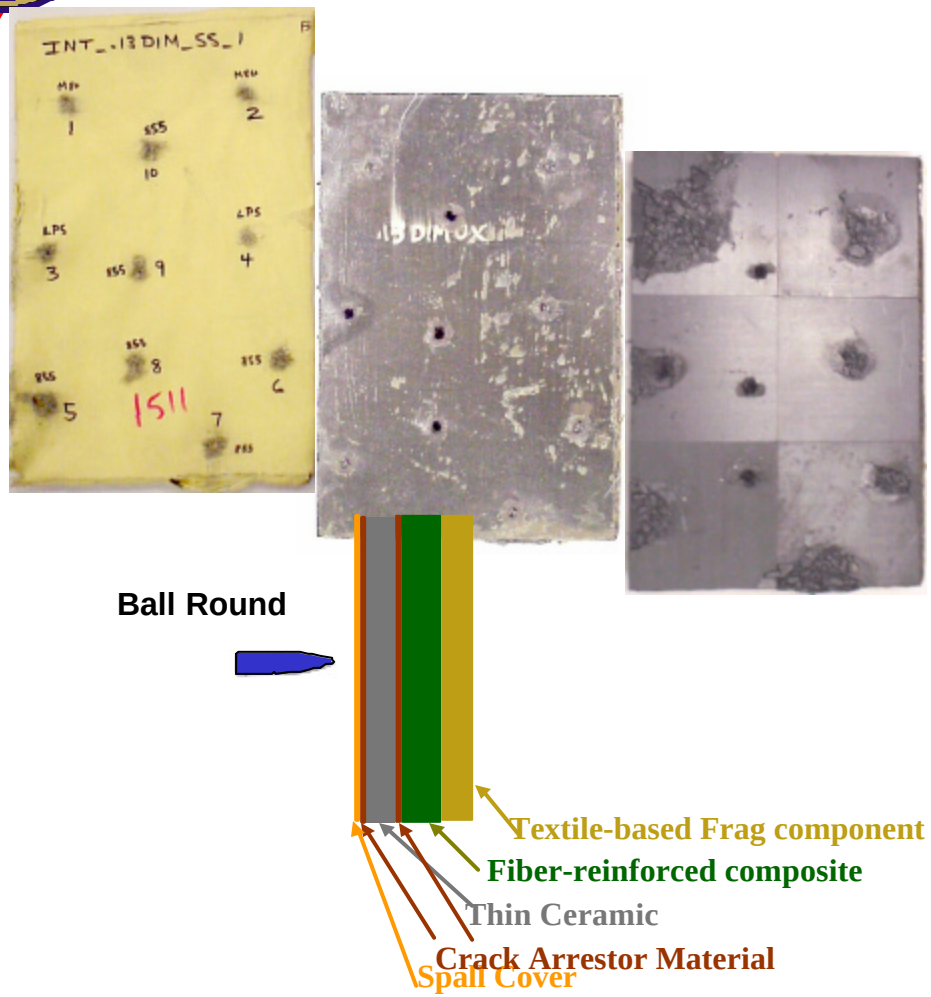
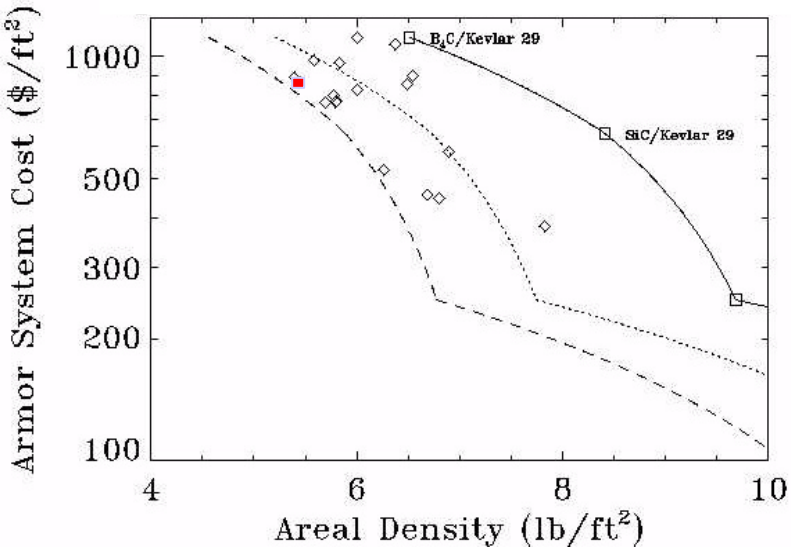


- **Increasing state-of-the-art materials performance through improved composite architectures**



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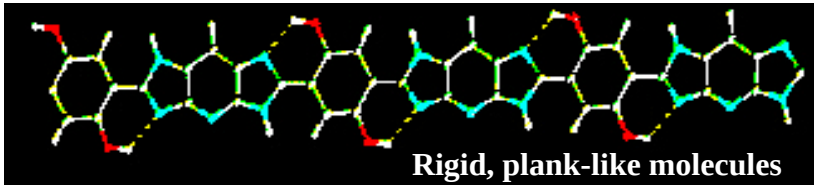
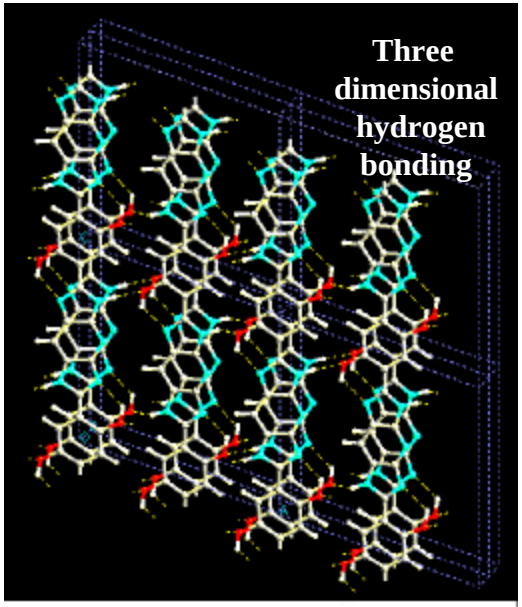
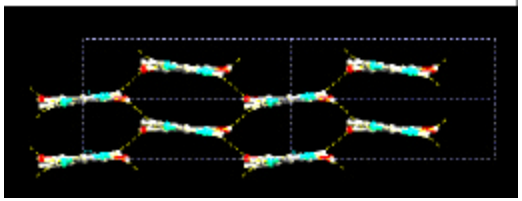
M5 - New Fiber Technology



- M5 fiber is a new high performance experimental fiber.



- M5 has extraordinary potential for use in armor systems for personnel and vehicles, flame and thermal protection, as well as high performance textiles.
- Current production of the fiber is at the bench scale using a batch process.
- Fiber properties are less than optimal under current processing conditions.
- Research ongoing to bring material properties to full potential
- Current business plan has full scale production occurring in the US (North Carolina State University)



Ballistic Protection for Improved Individual Survivability

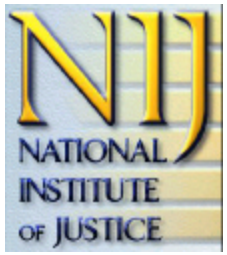
University of Rhode Island

Walter Reed Army Institute of Research

dstl

Leveraging / Interactions

Armed Forces Institute of Pathology



BACKUP

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BEHIND ARMOR EFFECTS TECHNICAL PROGRESS :

- **Established closer cooperative tie with Medical Research and Development community**
- **Established objective, dynamic biomechanical test method for accurately determining skull fracture potential of non-penetrating ballistic impacts on helmets. Validated through mechanical and cadaveric experimentation**
- **Established a risk of injury (fracture) curve for 9mm impacts on the helmet at various velocities, confirmed performance of current Army combat helmet (no skull fracture against non-penetrating 9mm)**
- **Substantiated low risk for neck injury due to non-penetrating high velocity 9 mm impact to helmet**
- **Transferred results of Army Head Injury Criteria to Army, Navy and USMC combat helmet developers.**
- **Conducted preliminary investigations of armor (vest/plates) on UK thoracic rig**
- **Established research methodology and instrumentation requirements for accomplishing an objective, dynamic, biomechanical test method for accurately determining blunt trauma limiting effects due to non-penetrating, high velocity, impacts on torso body armor**

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MODELLING TECHNICAL PROGRESS

- Completed Beta version of Monte Carlo assessment of ballistic insults and estimation of casualties with new Integrated Casualty Estimation Methodology (ICEM) model,
- Established ICEM website, codes, and user's manual, available on-site, for authorized users
- Started preliminary validation and verification (V&V) for ICEM Version 1.0
- Designed and manufactured selected glass/plastic and plastic/plastic configurations at areal densities ranging from 2.5 lb/ft^2 - 5 lb/ft^2 to establish performance profile against various threats (frag/9mm handgun), testing in progress
- Continued characterization of high strain rate mechanical properties of textile fabrics for use in analytical and hydrocode models

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MATERIALS TECHNICAL PROGRESS

- Transferred technology for 1st generation small arms (ball) protection; established new baseline (5.2 lb/ft^2) for 2nd generation 25% reduction in weight
- Demonstrated technology for 35% reduction in countermine system
- Identified and evaluated new fibers with potential to meet out-year milestones
- Identified mechanism to enhance transparent armor through modification of ductile to brittle transition for polycarbonate/polymethyl methacrylate

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MATERIALS TECHNICAL PROGRESS

- Completed characterization of emerging bullet threat mechanical properties and failure characteristics, established baseline areal density (10 lb/ft^2 for M993)
- Identified material phase change in baseline boron carbide (B_4C) ceramic against emerging threat which reduces performance of this ceramic, began investigation of alternate ceramics
- Conducted ballistic evaluations on early novel defeat concepts for emerging bullet threats providing insight in potential path forward
- Investigated the effect of processing pressure on mechanical properties and ballistic performance of ultrahigh molecular weight polyethylene composites with varying resin systems for 2nd generation ball protection, selected optimal candidate (s) for material integration evaluation with ceramics

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MATERIALS TECHNICAL PROGRESS

- Completed initial V_{50} evaluation of improved flat- panel laminated Zylon™ composite for fragmentation protection, demonstrated performance within 10% of FY03 objective. Environmental, flexural rigidity, transient deformation and ballistic performance of helmet shapes under evaluation
- Completed initial evaluation of improved flexible fabric armor systems. Demonstrated performance approaching goal performance. Results Classified. Environmental evaluations, cost reduction studies, and enhanced fabric architecture studies ongoing.
- Identified and started exploitation of new experimental high performance fiber, M5™ from Magellen Systems International. Fiber is being produced at bench scale with properties 1.5-2 times those of commercially available ballistic fibers. Potential for 3 times strength of Kevlar™. Working with company to bring to large scale production and commercial product. Current company plan is for production in the US